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On the structure and dimorphism of *Hypocrea tuberiformis*.

GEO. F. ATKINSON.

(WITH PLATE XXV.)

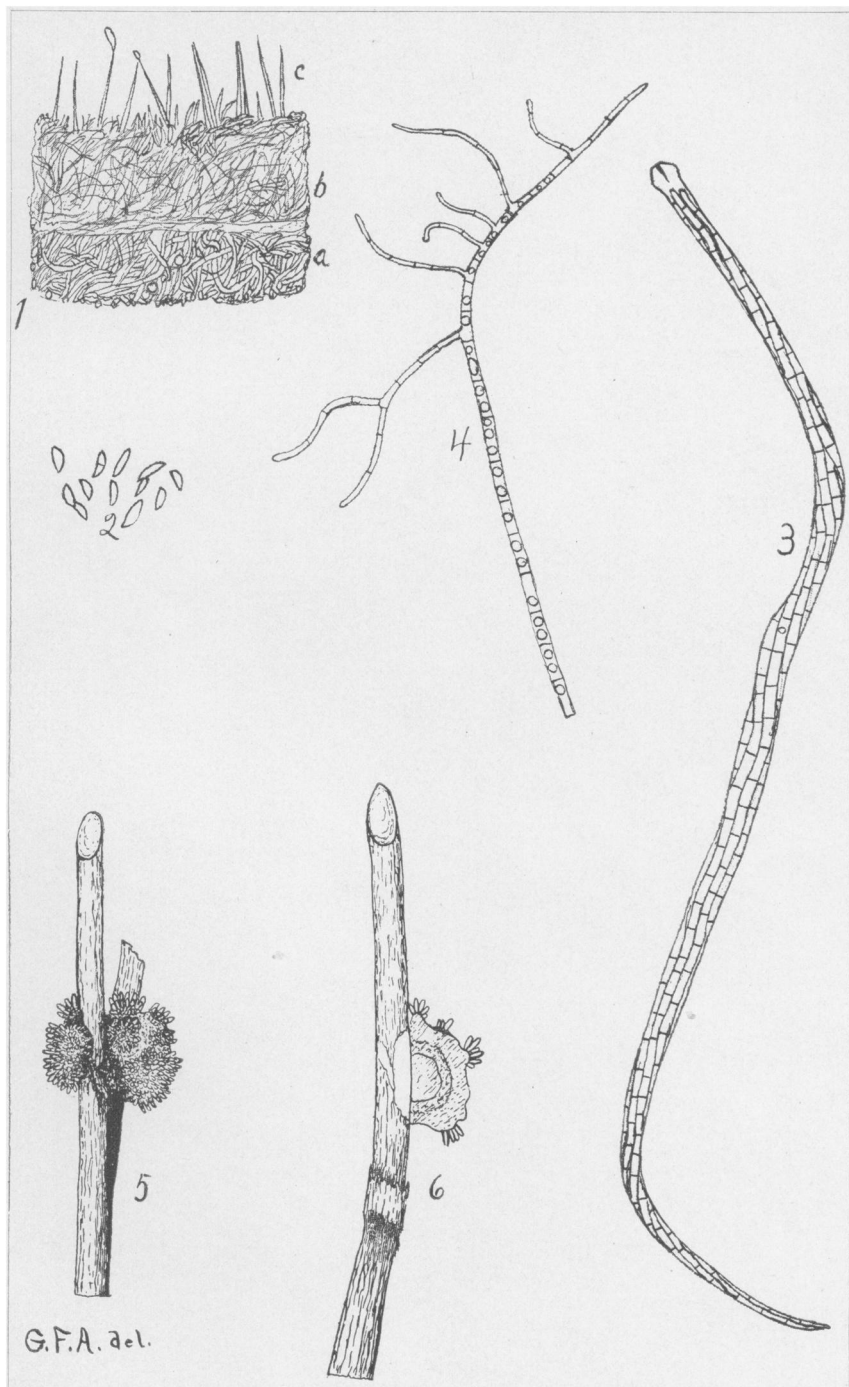
Hypocrea tuberiformis was described as follows by Berkeley in Grevillea IV, p. 13, from specimens collected by Ravenel in South Carolina: "Magna tuberiformis mycelio radiata albo affixa. On stems of *Arundinaria*. Car. Inf. Ravenel. No. 1220. Forming either a large mass $\frac{3}{4}$ of an inch across, or two or three distinct subglobose individuals, fixed to the stem by a radiating white rugose mycelium; at first yellowish, then black."

It was also distributed in Rav. F. Am. n. 733, and in Rav. Fung. Car. n. 52. Most of the specimens collected by Ravenel were probably sterile, since there is, to my knowledge, no published description of the forms of this dimorphic fungus.

Saccardo (Sylloge Fungorum II, p. 534) repeats Berkeley's description. Ellis and Everhart (Journal of Mycology II, p. 68) place it in the group of *Hypocreaceæ*, which constitutes Saccardo's genus *Hypocrella*, and add the following note, probably taken from specimens distributed by Ravenel: "Apparently the original specimens were imperfect and, as those in Rav. F. Am. are either young or sterile, we can only say that the perithecia are subcylindrical and stand on the stroma like the young horns of *Podisoma macropus*, about one millim. high."

Patouillard (Bull. de la Société Mycologique de France, VI, 2e fasc. pp. 107-9, 1890) describes a new genus of *Hypocreaceæ* under the name *Dussiella*. The perfect condition of the fungus he examined was deposited in the Berlin Museum and collected on stems of *Arundinaria* at Caracas, the conidial stage from specimens collected by Duss in Martinique. He considers these forms to be the conidial and ascosporeous stages of *Hypocrea tuberiformis* B. & R., but unquestionably it is a very distinct fungus from the one described by Berkeley, from Ravenel's collection.

The perithecia are entirely immersed in the stroma, paraphyses are present, and while, as he states, the linear ascospores show its relationship to *Epichloe* and *Hypocrella*, the



G.F.A. del.

ATKINSON on HYPOCREA.

peculiar structure of the apex of the asci in *Epichloe* and *Hypocrella* is not present in his specimens, or at least not represented in the illustration. I first collected sterile forms of *Hypocrea tuberiformis* B. & R. on *Arundinaria* at Columbia, S. C., during the winter of 1888-1889. During the last two years I have collected at Auburn, Ala., its sphacelia and ascigerous stages.

STROMA.—The stroma is subglobose, entire, lobed, or divided, seated upon the reed or upon the leaf sheath and fastened by a whitish mycelium, consisting of radiating, undulate threads, which sometimes become tinged with yellowish brown. It consists of two different strata when young, composed of slender, compactly interwoven hyphæ. The outer stratum is quite opaque, as shown in section, and yellowish. It is connected with the inner white stratum by loose threads. The whole is of a leathery or corky consistence. When mature a section shows three differently colored strata; an inner layer, white, which is sometimes tinged with pink; an intermediate layer, light ochre; and an outer layer, cinnamon. The intermediate layer is not quite so compact as the outer two. After the stroma is dead it sometimes becomes black.

SPHACELIA STAGE.—The sphacelia stage occurs at Auburn, Ala., in late spring. I first collected it May 10, 1890. The conidiophores radiate from the surface, which they thickly cover, and are needle-shaped, tapering gradually to a sharp point where the conidia are borne. They measure 35-40 μ long by 2-3 μ at the base. The conidia are oval or broadly fusoid, inequilateral, hyaline, mostly continuous, but the larger ones sometimes faintly one-septate. Size, 3.5-4 \times 7-10 μ .

ASCIGEROUS STAGE.¹—The perithecia are sessile, or only the rounded base immersed in the superficial part of the stroma. They are subcylindrical, a little broader in the middle than at each end, floccose, with loose white threads through which the cinnamon color shows. The apex is smooth and resembles the apex of *Epichloe typhina* (Pers.) Tul. The ostiolum is distinct. They are about 1 millimeter long by one-third of a millimeter in diameter, and stand on the stroma singly or in groups of 3-4-20, or crowded over a large portion. They are frequently branched, the bases of two, three or more being joined and the cavities confluent below.

¹ Mature in August and September.

The asci are 8-spored, very large, varying from $450-750 \times 14\mu$, tapering to a slender point at base, more gradually toward the truncated apex. They are very stout at the apex, somewhat like those of *Epichloe typhina* (Pers.) Tul. and *Hypocrella atramentosa* (B. & C.) the end being slightly enlarged, conoid and truncate.

The ascospores are linear, hyaline, pluriguttulate and pluriseptate, rounded at each end, at maturity separating at the septa and frequently germinating while yet within the perithecia, the germ tubes arising from any of the segments, sometimes before the sporidia separate at the septa. In most of the asci there is indication of a narrow slit through the apex, represented by a dark line, but I have never seen the spores escape through it. I have observed the same thing in the asci of *Epichloe typhina* (Pers.) Tul., but have not been able to determine positively whether it is a slit or only an opaque line.

We are able to see from this study the affinity of *Hypocrea tuberiformis*, B. & R., with *Epichloe*, since its only disagreement lies in the fact that the stroma of *Epichloe*, as characterized, entirely surrounds the stem of its host, while those agreeing in all essential parts of structure, but only partially surrounding their hosts, are provided for in Saccardo's genus *Hypocrella*. It thus frequently transpires that the genetic relationship of some forms is determined by fortuitous circumstances rather than by structural affinity.

Hypocrea atramentosa B. & C. might have been an *Epichloe* were it not for the fact that it appears too early in the season upon the opening buds of *Andropogon Virginicus*. These it first entirely embraces with its infant stroma, when later *Andropogon* rises, tears it asunder, bears it only upon the underside of the leaves in the cluster, and leaves it nothing but a *Hypocrella*! But, until a monographic study can be made of members of both genera, *Hypocrea tuberiformis*, B. & R. should read, *Hypocrella tuberiformis* (B. & R.) My specimens were collected on *Arundinaria macrosperma* Michx. var. *suffruticosa* Munro (*Arundinaria tecta* Muhl.)

I take this opportunity of noting the favor extended by Mr. B. T. Galloway, Chief of the Division of Vegetable Pathology, Washington, D. C., in allowing me the use of the Bull. de la Soc. Myc. de France, *tom. cit.* and Ravenel's two exsiccati,

Fung. Am. and Fung. Car. I find that n. 52 of the latter is a perfect condition of this fungus.

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EXPLANATION OF PLATE XXV.—*Hypocrella tuberiformis* (B. and R.) Atkinson Fig. 1, section of portion of young stroma; *a* inner layer; *b* outer layer; *c* conidio-phores. Fig. 2, conidia. Fig. 3, ascus with linear ascospores. Fig. 4, portion of ascospore germinating. Fig. 5, perfect condition, stroma bearing perithecia. Fig. 6, section of stroma. Figures 5 and 6 are magnified about $1\frac{1}{2}$ times, the other figures much more.

Notes on the Flora of Canada.

JAMES M. MACOUN.

During the season of 1890 a considerable number of plants were discovered in various parts of Canada that were either new to the Dominion or were of sufficiently rare occurrence to be worthy of note. Except when otherwise mentioned all the plants in this list were collected by Prof. Macoun and myself in British Columbia. The asterisk (*) after the name of a plant signifies that it had not before been found in Canada.

1. *Thalictrum Fendleri* ENGELM.*—Very abundant in low grounds at Kicking Horse Lake, Rocky Mts.

2. *Ranunculus hispidus* MX. var. *Oreganus* GRAY.*—Low grounds at Sproat, on the Columbia River, 15 miles north of the International Boundary, and on the Kootenay river, about half way between Sproat and Kootenay lake, B. C.

3. *Ranunculus hederaceus* L.*—Marshes near New Harbour, Newfoundland. Collected by Rev. A. C. Waghorne in 1889 and 1890.

4. *Isopyrum biternatum* TORR. & GR.*—Abundant in the vicinity of London, Ontario. Collected by J. Dearness.

5. *Delphinium simplex* DOUGL.—Very abundant on rocky banks, about 2 miles above the junction of the Kootenay and Columbia rivers, B. C.

6. *Papaver nudicaule* L. var. *arcticum*, ELKAN.—One clump of about twenty specimens was found on the mountains at Kicking Horse Lake, Rocky Mts., at an elevation of 8,000 feet.